Real-time Small Aircraft Transportation Systems (SATS) engineering test bed for the definition, development, and validation of operations using an Airborne Internet (AI) architecture

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Presentation outline

- Background - simulation objective
- Assumptions of SATS objectives
- Current simulation capability
  - Engineering test bed features
  - What can be tested and developed
- Near term upgrade (Phase I)
- End-state architecture (Phase II)
- Example

Background - Simulation objective

NASA, FAA, State and local aviation organizations in partnership to support research and development focused on maturing SATS enabling technologies. Simulation test bed support objectives

- Higher volume operation at non-towered/non-radar airports
- Lower landing minima at minimally equipped landing facilities
- Increase single-pilot crew safety and mission reliability.
- En route procedures and systems for integrated fleet operations.

SATS Assumptions I

Higher volume operation at non-towered/non-radar airports

Underlying the Higher Volume Operations (HVO) is a newly defined area of flight operations called an HVO Self Controlled Area (SCA) for SATS airports.

Initial goal: *Five simultaneous operations in non-radar airspace*

Assumptions

- All HVO aircraft have a minimum approved set of equipage
- Pilots assume responsibility for self-separation
- HVO airport has an Airport Management Module
- Airport has automatic weather observing/reporting capability.
- Operations may be conducted in IMC
- No special provision required for separation from non-participating traffic (“see and avoid” in effect per FAR Part 91.113)
- Approaches are “published” may be sent from the ground from a pre-approved set and are not dynamically calculated

SATS Assumptions II

Lower landing minima at minimally equipped landing facilities

Increase single-pilot crew safety and mission reliability

Assumptions

- All HVO aircraft have a minimum approved set of equipage
- Pilots assume responsibility for self-separation
- HVO airport Airport Management Module **can provide integrity and/or navigation guidance verification**
- Airport has automatic weather observing/reporting capability.
- Operations may be conducted in IMC
- No special provision required for separation from non-participating traffic ("see and avoid" in effect per FAR Part 91.113).
- Approaches are "published" (they may be sent up from the ground from a pre-approved set and are not dynamically calculated)
- **Crew safety and mission reliability can be supported and/or monitored by data link facilities at SATS facilities**

SATS Assumptions III

En route procedures and systems for integrated fleet operations

Assumptions

- HVO airport has an Airport Management Module
- **Data link connectivity to aircraft is maintained for ATC transfer of control (ingress and egress) from SATS/ SCA**
- Airport has automatic weather observing/reporting capability.
- Operations may be conducted in IMC
- **In the en route phase of flight, if the aircraft is operating under IFR it is assumed the aircraft is under positive ATC control**
- **Operations are conducted under FAR Part 91 as much as possible**.
- No special provision required for separation from non-participating traffic ("see and avoid" in effect per FAR Part 91.113).
- Approaches are "published" (they may be sent up from the ground from a pre-approved set and are not dynamically calculated).

Simulation capability

Simulation Levels

LEVEL 1 — Monolithic aircraft and flight dynamics process that ignores communications issues

LEVEL 2 — Monolithic process but includes communication messages

LEVEL 3 — Accurate flight dynamics with communications but pilot/controller actions simulated

LEVEL 4 — Builds on level 3 by providing a real pilot cockpit and controller workstation with higher levels of fidelity (PITL simulations)

LEVEL 5 — Real aircraft performing flight tests with integrated air/ ground simulators

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Engineering test bed I

Communications architecture builds on AI concepts and includes functionality required for HVO SATS radios

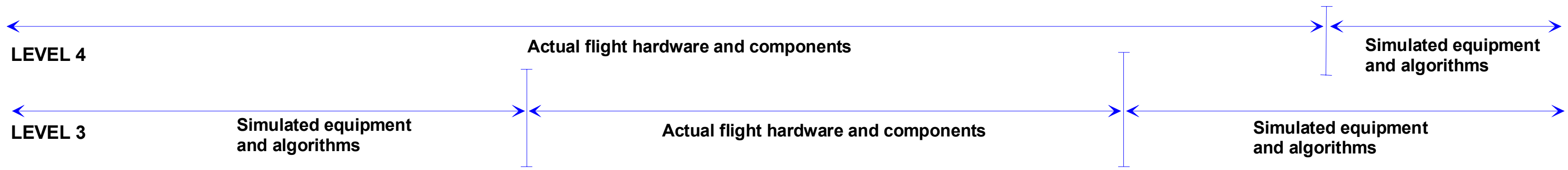
- ADS-B and CDTI
- GPS
- Datalink
- uplink broadcast datafeed (broadcast FIS-B)
- downlinked datafeed acknowledgements
- air/air, air/ground, and ground/air messaging for e-mail, IP traffic, CPDLC and chat messages

Engineering test bed II

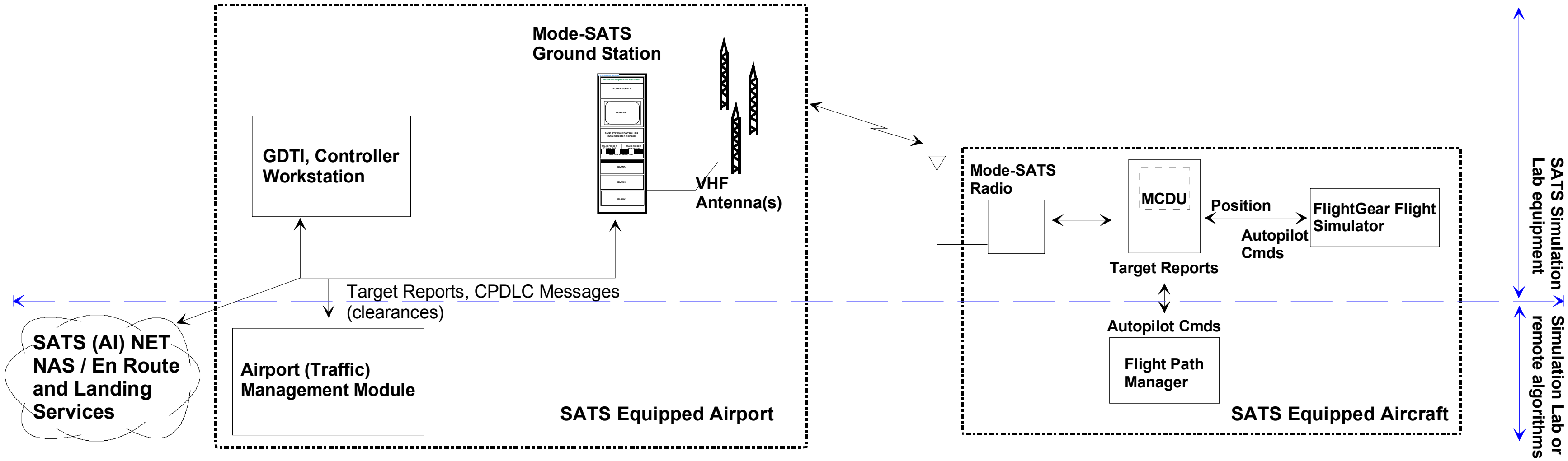
Other development engineering components integrated presently include:

- Modified FlightGear flight simulator is a sophisticated flight simulator framework developed with NASA Glenn
- The Multi-Function Control and Display Unit (MCDU) (converts uplinked commands into directions to the FlightGear)
- Flight Path Manager (receives ADS-B position reports)
- Airport Management Module (resides in the ground station or is remotely located on researcher's computer)
- Datalink to TCP/IP networks (Firewall, VPN and RMM)
- The Ground Display of Traffic Information (allows simulation director to monitor performance of simulation)
- Research IP network (provides simulation monitor, software, data transfer and logging)

Current test bed features



Real-time Small Aircraft Transportation System (SATS) Airborne Internet Engineering Test Bed



CURRENT LAB EQUIPAGE

What can be tested now I

Allows HITL and PITL testing of:

- airborne internet functionality and performance
- airborne automation
- ground automation
- pilot/automation interaction
- controller/automation interaction
- pilot/pilot and pilot/controller procedures interaction
- procedures for en-route/SCA and SCA/en-route transitions

What can be tested now II

Additional features:

- Downlink acknowledgement of uplink broadcast FIS-B transmissions
- Different sequencing of FIS-B data based upon aircraft location, priority of the uplinked data, and other factors
- Text-to-speech of uplinked data (minimize head-down time)
- Remote development of airborne automation
- Remote development of ground automation
- PITL simulation

Simulator Conops View

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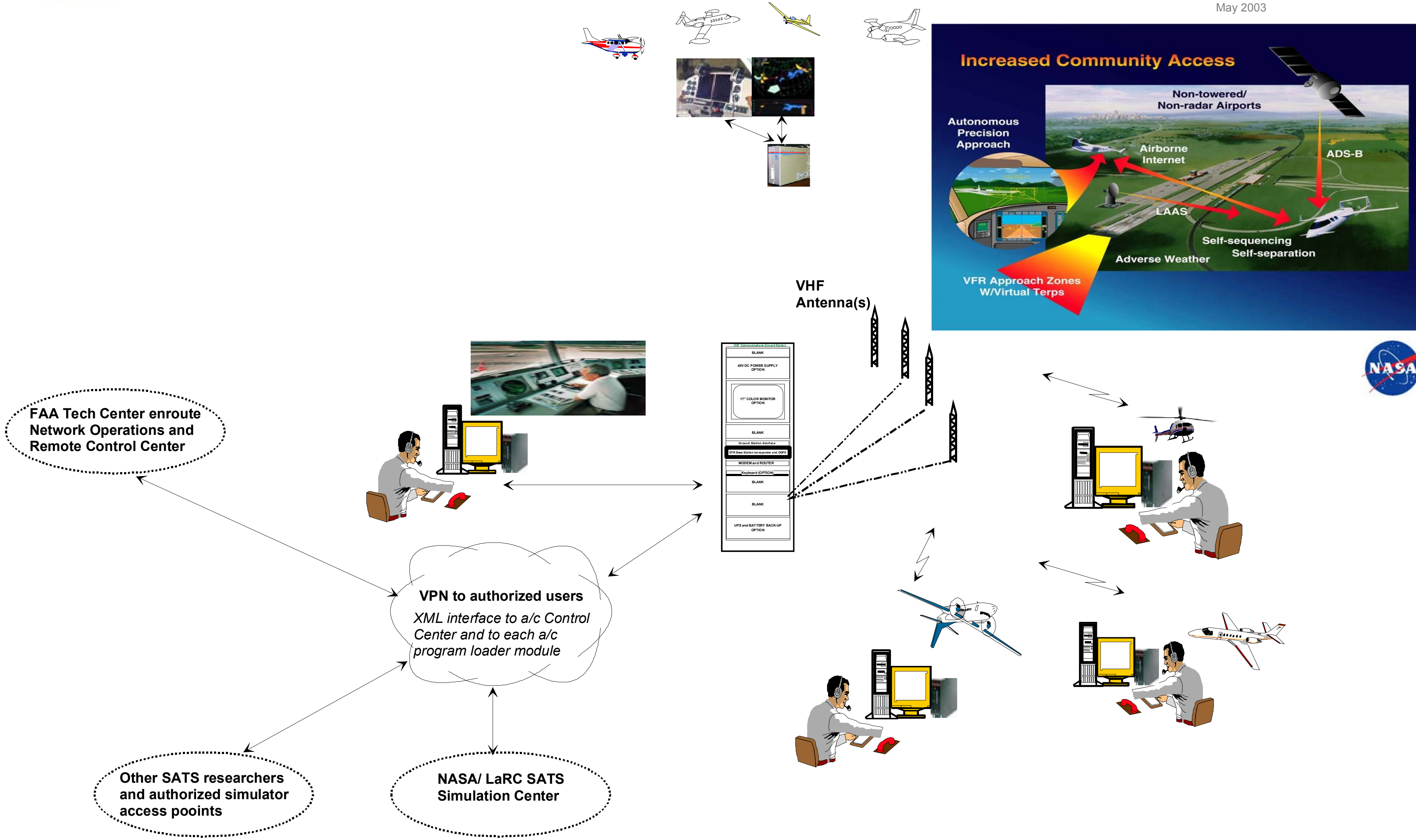
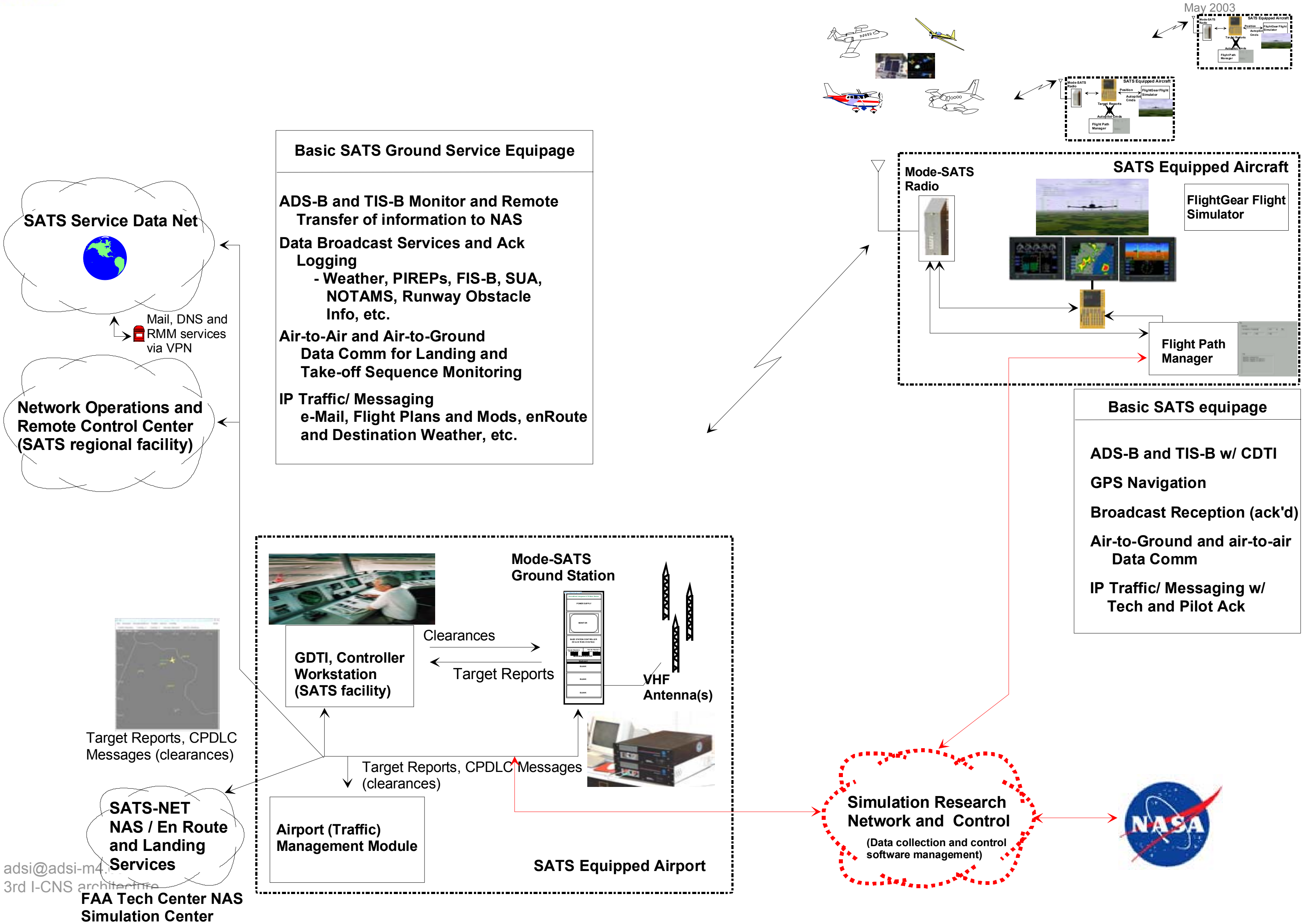


Level 4 simulator components



An example

Cessna-310 (N507NA) is making an approach to Leesburg Airport (JYO).

An example

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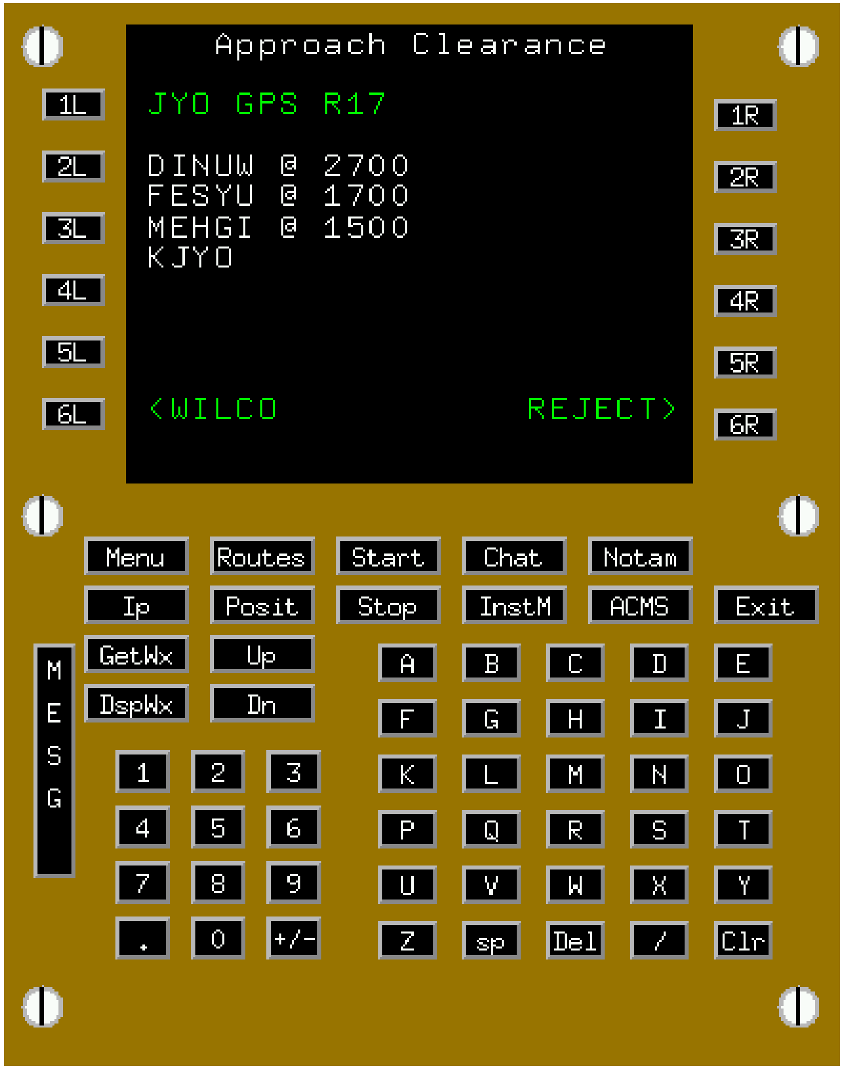

An example

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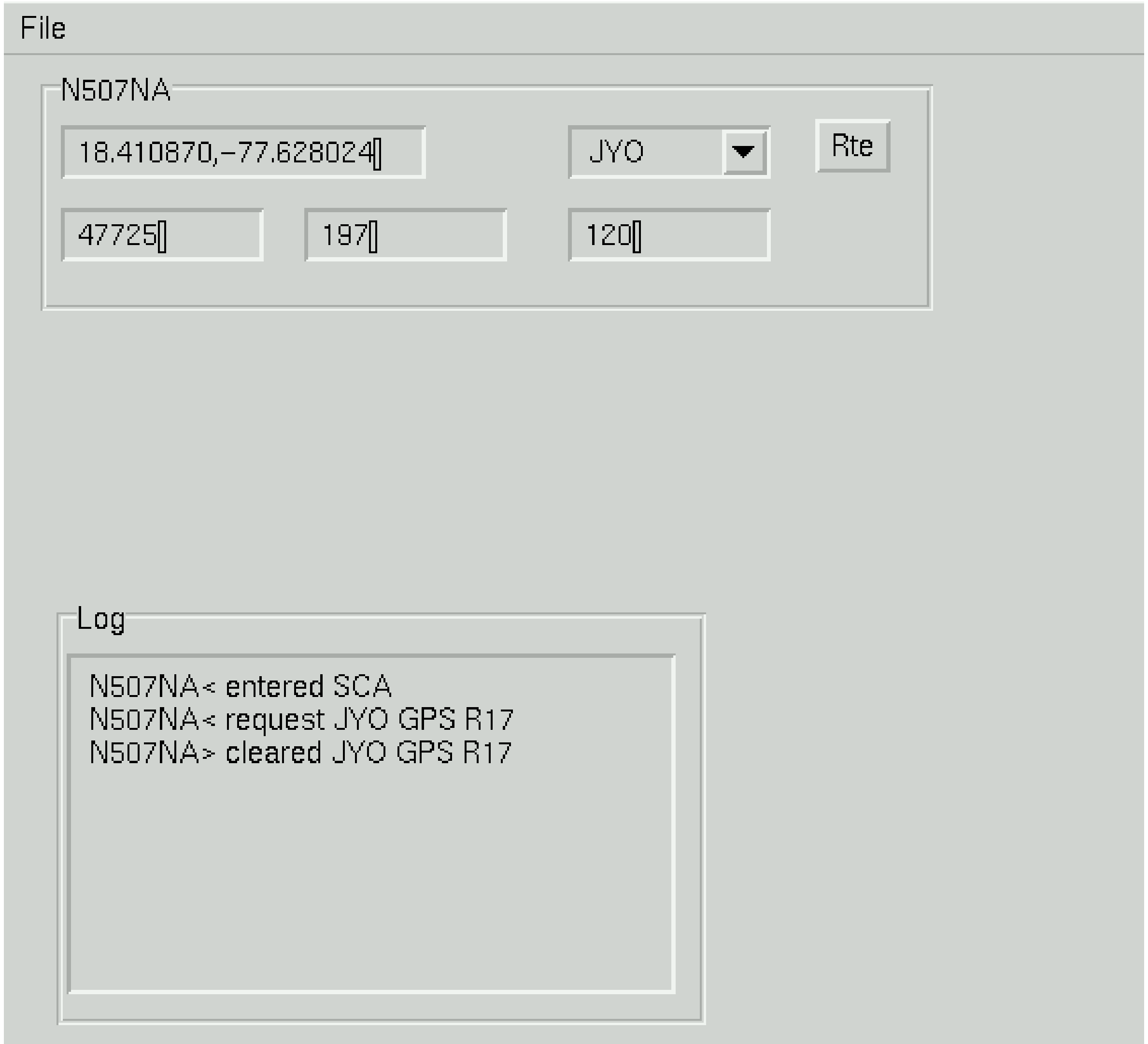

An example

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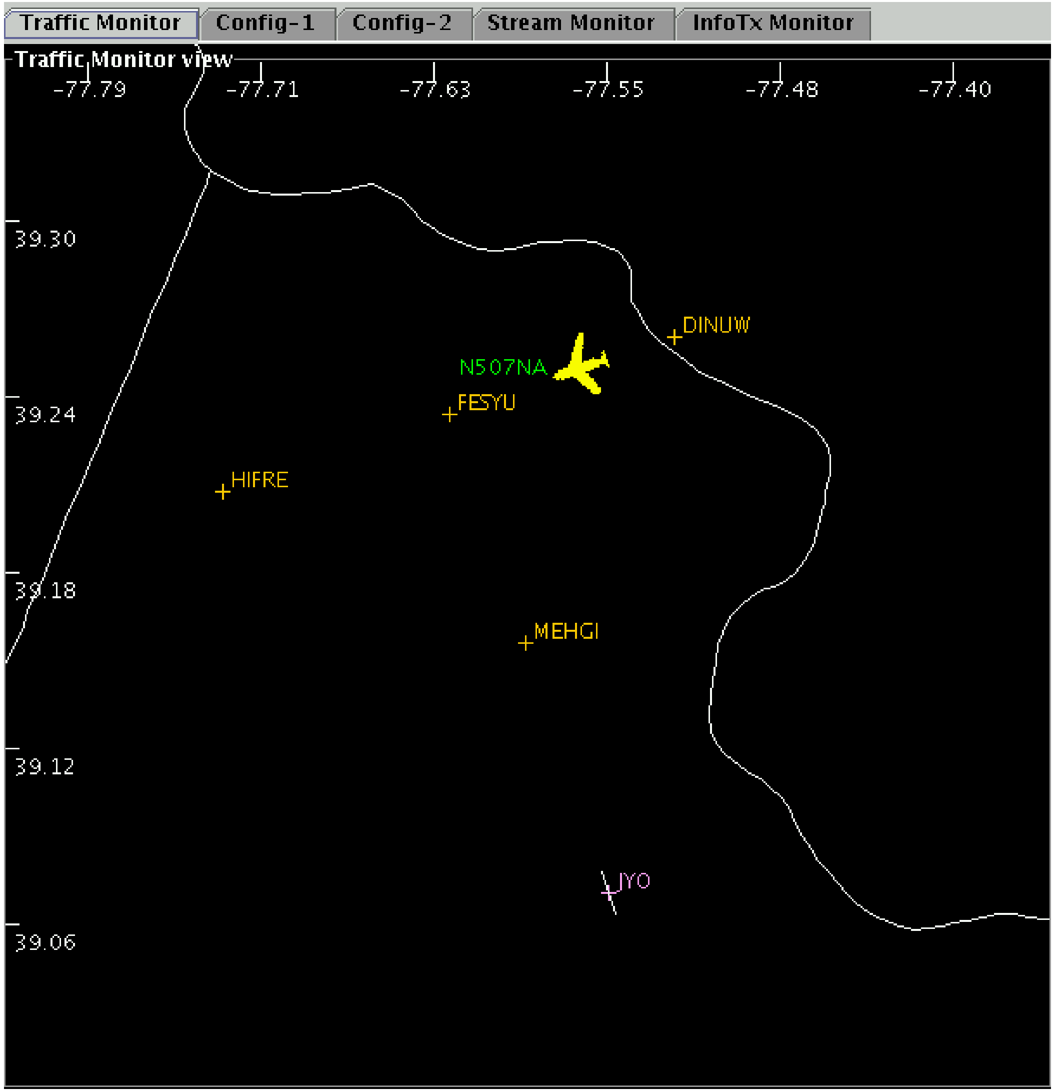

Future work

- Support the NASA HVO development program
- Participate in the VASATSLab program
- Continued development of the ADN concept and simulations in support of the AI Forum
- Progress simulator from Level 3 to Levels 4 and 5